Veno-Arterial Extracorporeal Membrane Oxygenation (VA-ECMO) for Cardiogenic Shock

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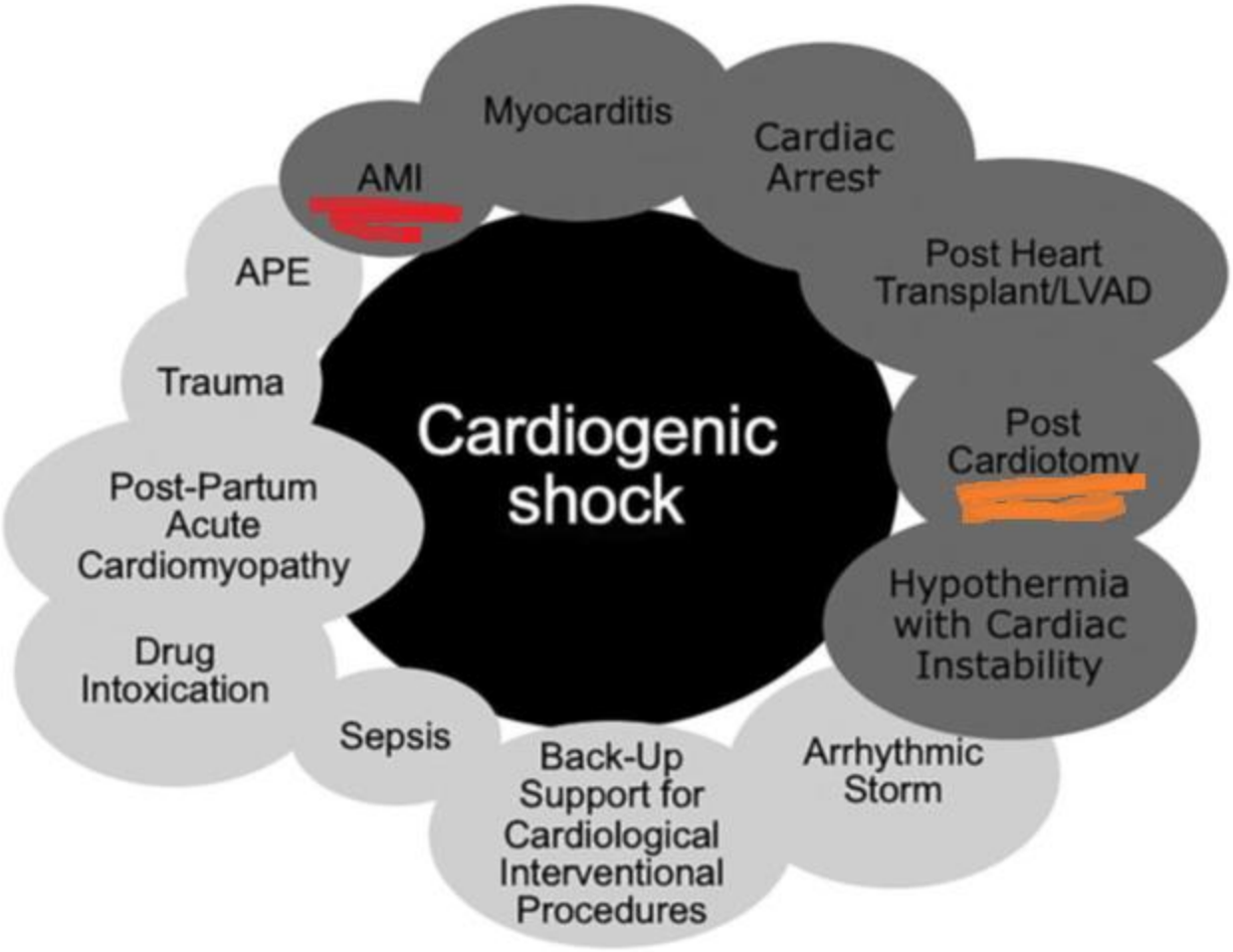
What is a cardiogenic shock?

It is the inability of
the heart to maintain an effective cardiac output
commensurate to the metabolic demands of
the body attributable to a primary underlying
cardiac pathology

Causes of cardiogenic shock



Definition criteria of cardiogenic shock

Clinical Features of Cardiogenic Shock and Defined Contemporary Trials and Guidelines

Clinical Trial/ Guidelines	Cardiogenic Shock Criteria
SHOCK Trial (1999)	• SBP < 90 mm Hg or vasopressor support to maintain SBP >90 mm Hg • Evidence of end-organ damage (UO < 30 ml/h or cool extremities) • Hemodynamic criteria: CI < 2.2 and PCWP > 15 mm Hg
IABP-SOAP II (2012)	• MAP < 70 mm Hg or SBP < 100 mm Hg despite adequate fluid resuscitation (at least 1 L of crystalloid or 500 ml of colloids) • Evidence of end-organ damage (AMS, mottled skin, UO < 0.5 ml/kg/h for 1 h or serum lactate >2 mmol/L)
EHS-PCI (2012)	• SBP < 90 mm Hg for 30 min or inotropes use to maintain SBP >90 mm Hg • Evidence of end-organ damage and increased filling pressure
ESC-HF Guidelines (2016)	• SBP < 90 mm Hg with appropriate fluid resuscitation with clinical and laboratory evidence of end-organ damage • Clinical: cold extremities, oliguria, AMS, narrow pulse pressure. Laboratory: metabolic acidosis, elevated serum lactate, elevated serum creatinine
KAMIR-NIH (2018)	• SBP < 90 mm Hg for >30 min or supportive intervention to maintain SBP >90 mm Hg • Evidence of end-organ damage (AMS, UO < 30 ml/h, or cool extremities)

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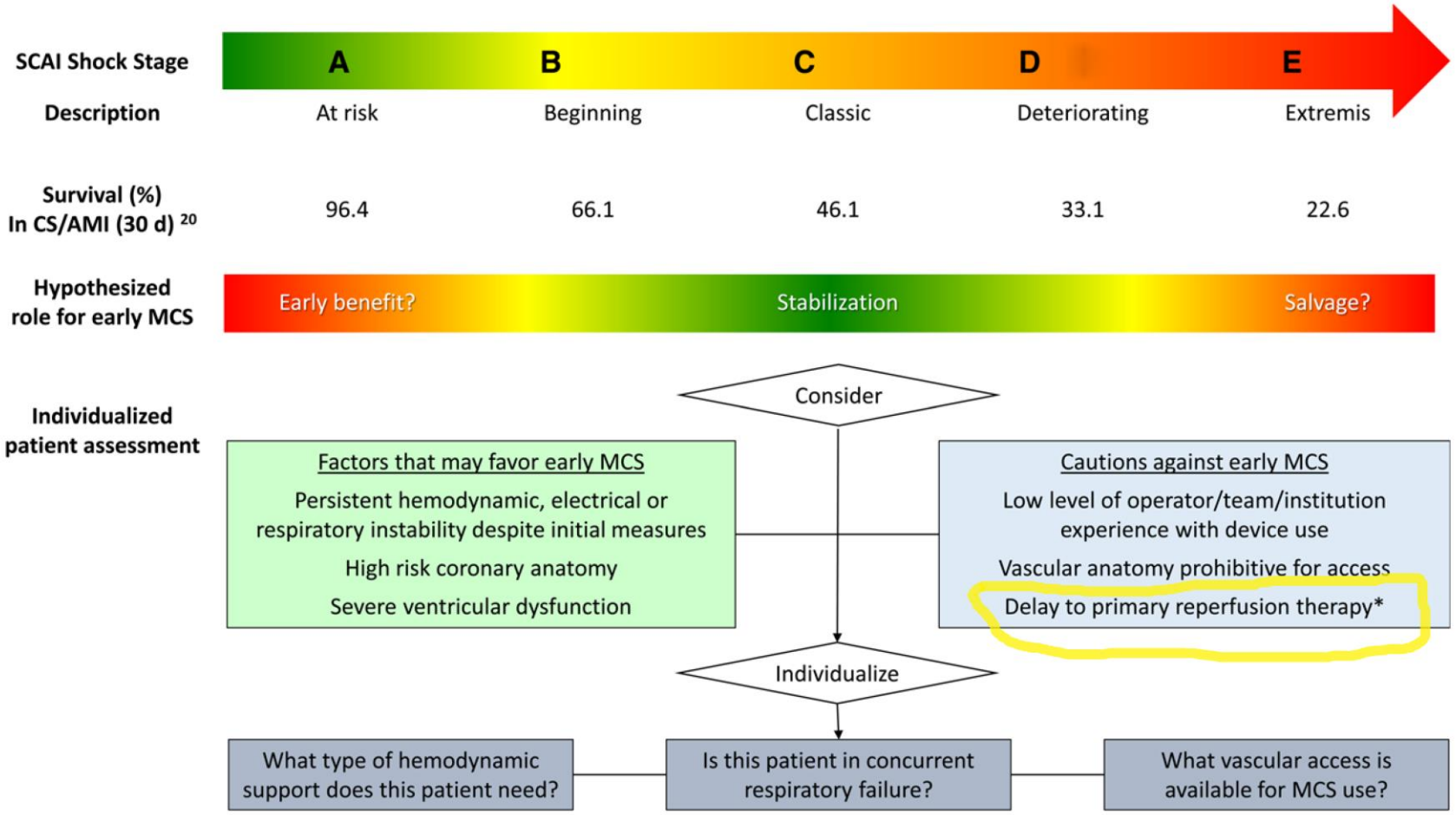
WILEY

SCAI clinical expert consensus statement on the classification of cardiogenic shock

This document was endorsed by the American College of Cardiology (ACC), the American Heart Association (AHA), the Society of Critical Care Medicine (SCCM), and the Society of Thoracic Surgeons (STS) in April 2019

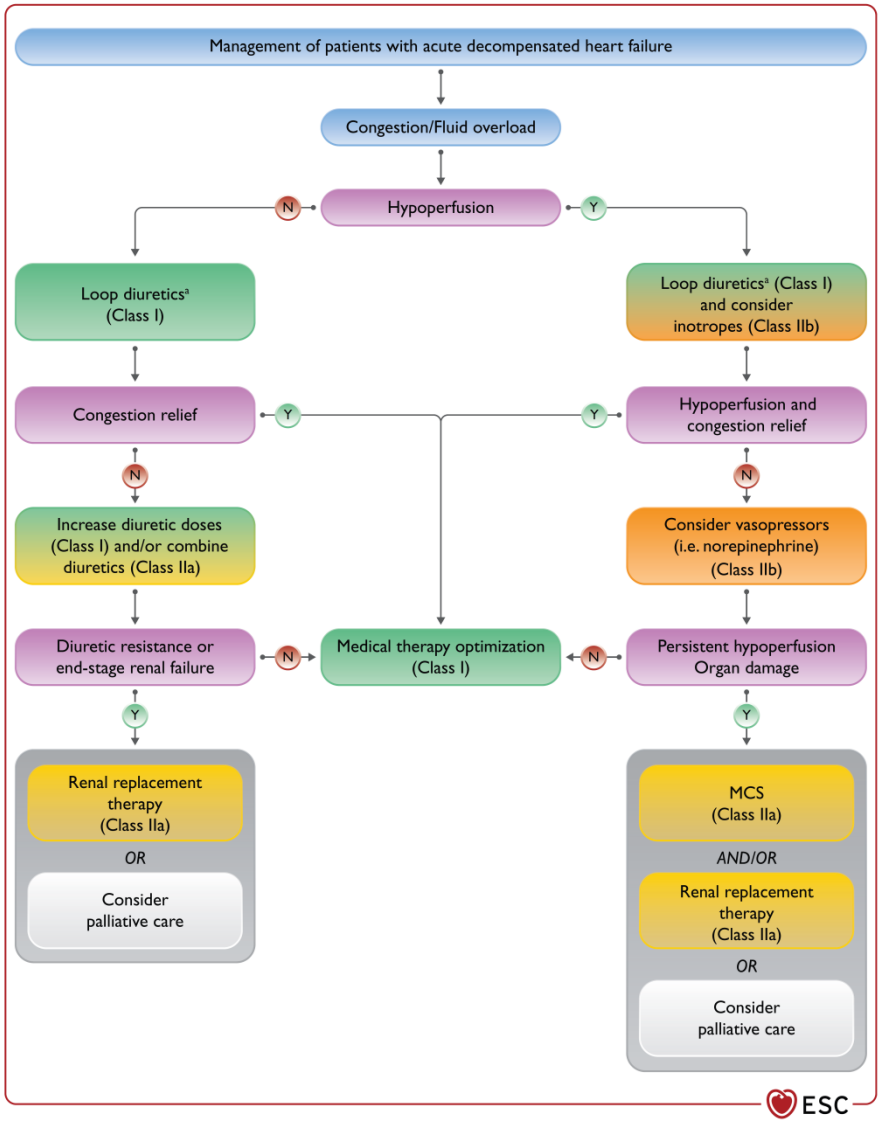


*Implications of time delay incurred during MCS initiation before primary reperfusion therapy are uncertain pending dedicated trials in the setting of cardiogenic shock complicating AMI.

ESC European Society of Cardiology
European Heart Journal (2021) 42, 3599 – 3726
doi:10.1093/eurheartj/ehab368

2021 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure

Developed by the Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)



Mechanical circulatory support

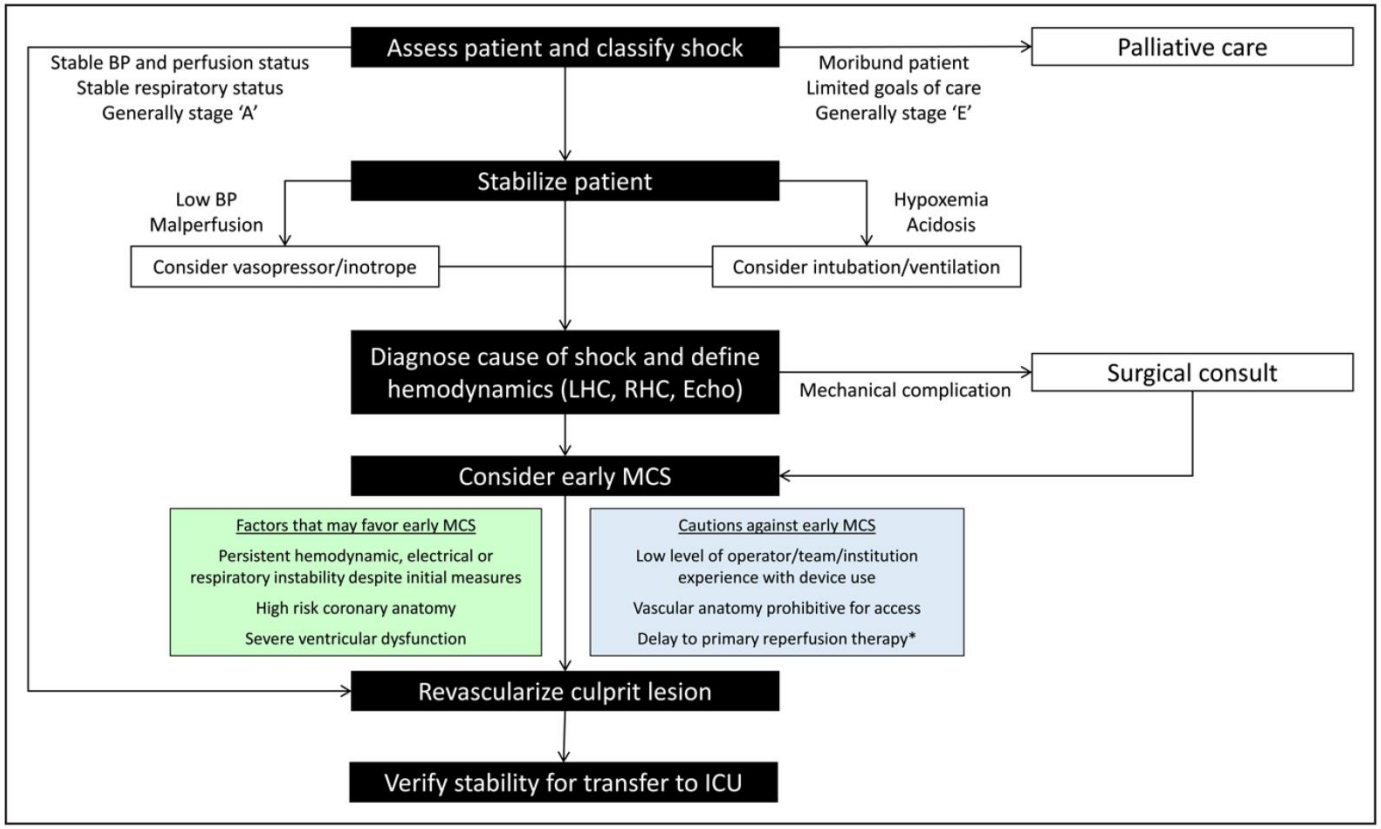
Circulation

AHA SCIENTIFIC STATEMENT

Invasive Management of Acute Myocardial Infarction Complicated by Cardiogenic Shock

A Scientific Statement From the American Heart Association

Circulation. 2021;143:e815–e829.



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Patients presenting in shock (stages C–E) may first require acute stabilization with attention to blood pressure, endorgan perfusion status, oxygenation, and acid-base status.

Especially in cases of STEMI, any necessary stabilization efforts must be expedited to minimize delay to reperfusion therapy

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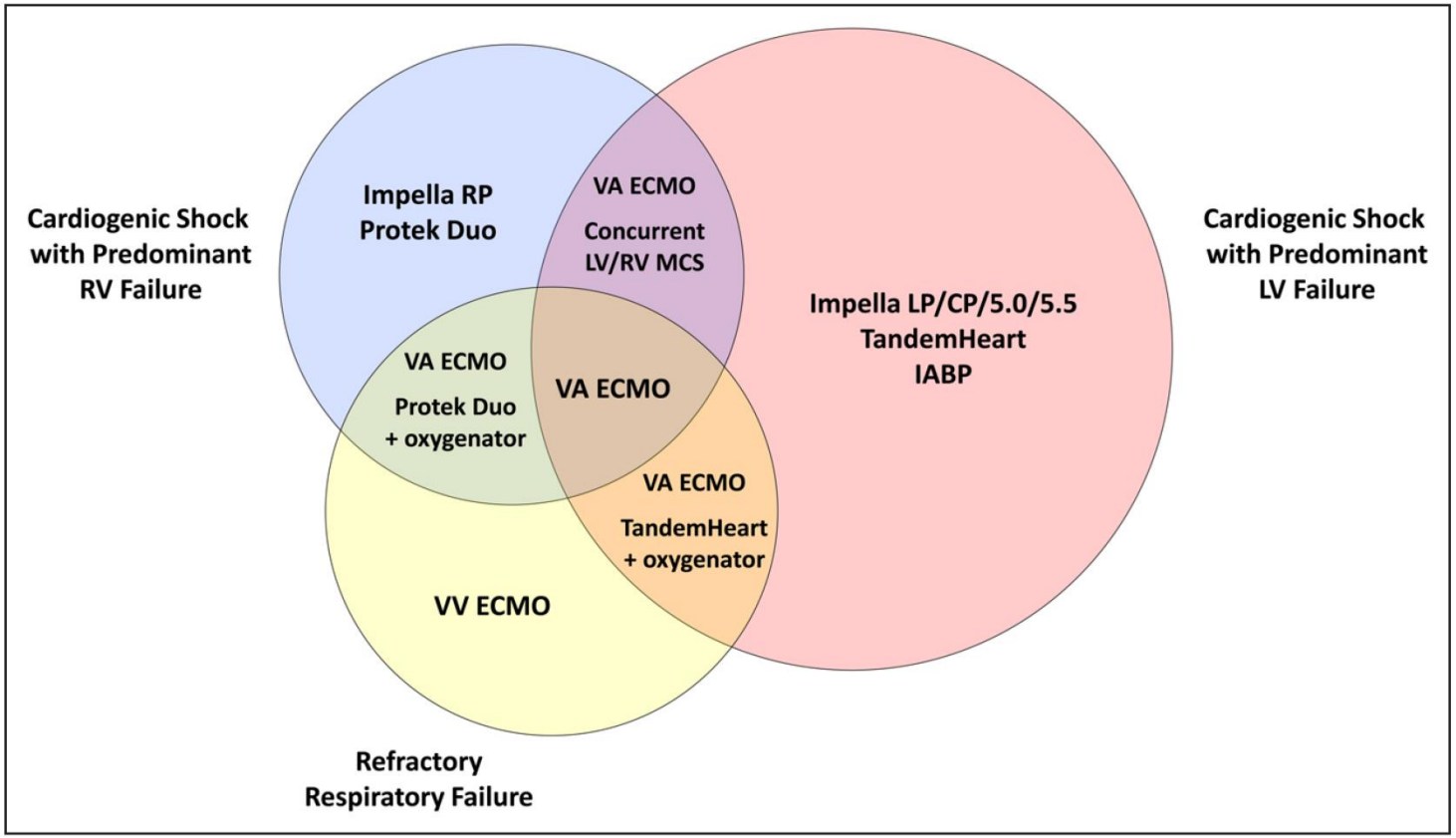
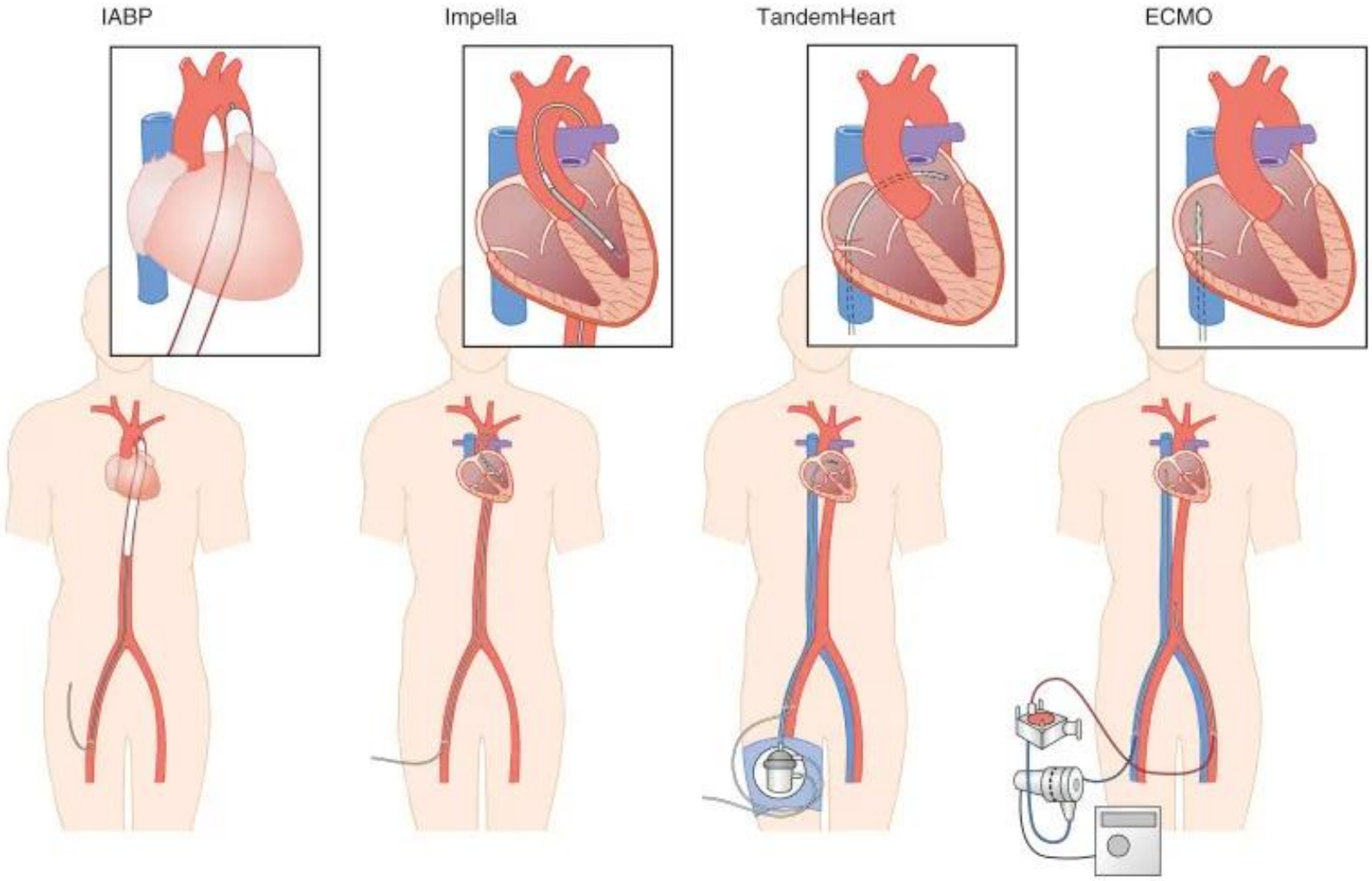


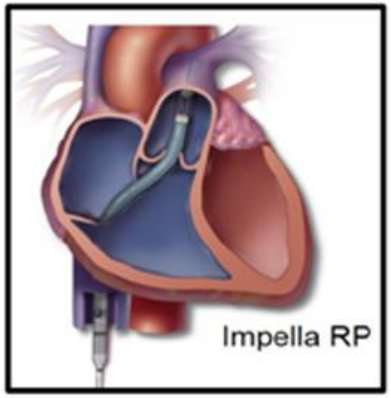
Main mechanical circulatory support strategies for cardiogenic shock

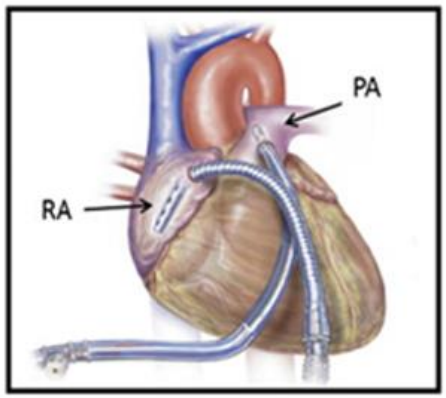


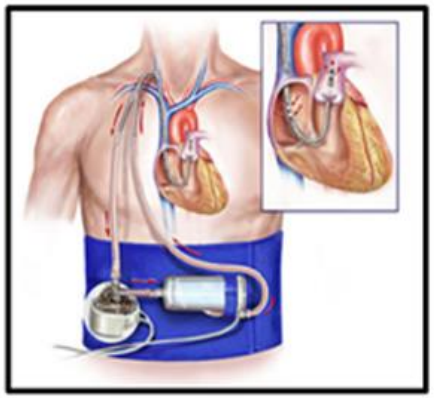
Mechanical circulatory support strategies for right ventricular failure

Direct RV Bypass

Indirect RV Bypass







Impella RP | Tandem RVAD | Protek Duo | VA-ECMO

Axial Flow | Extracorporeal Centrifugal Flow

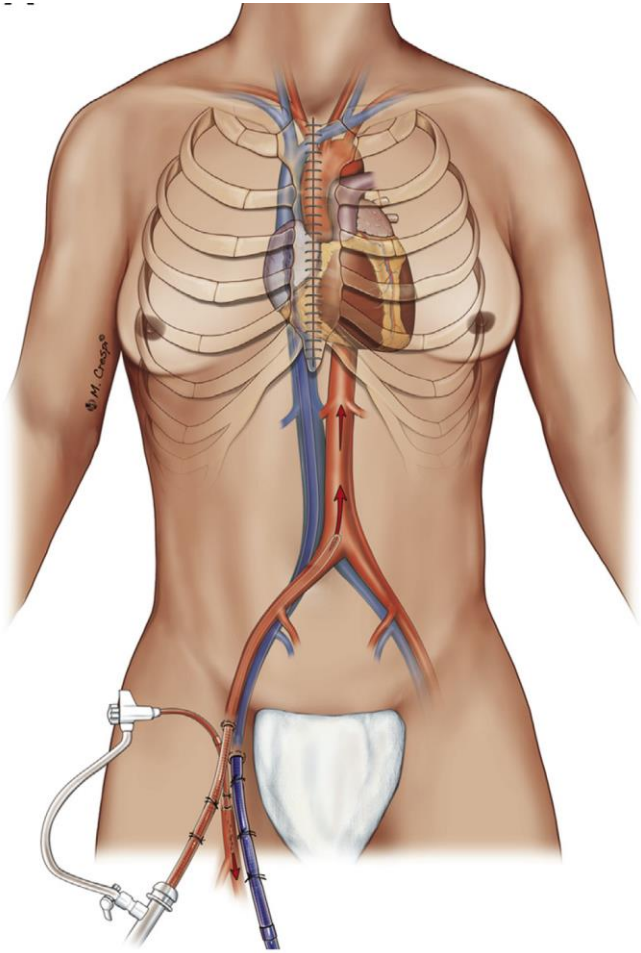
What is a VA-ECMO?

V-A support is the application of ECC primarily for cardiocirculatory or cardiopulmonary support, in which the extracorporeal circuit drains blood from the venous system and returns it to the systemic arterial system oxygenated and normalized for pCO_2

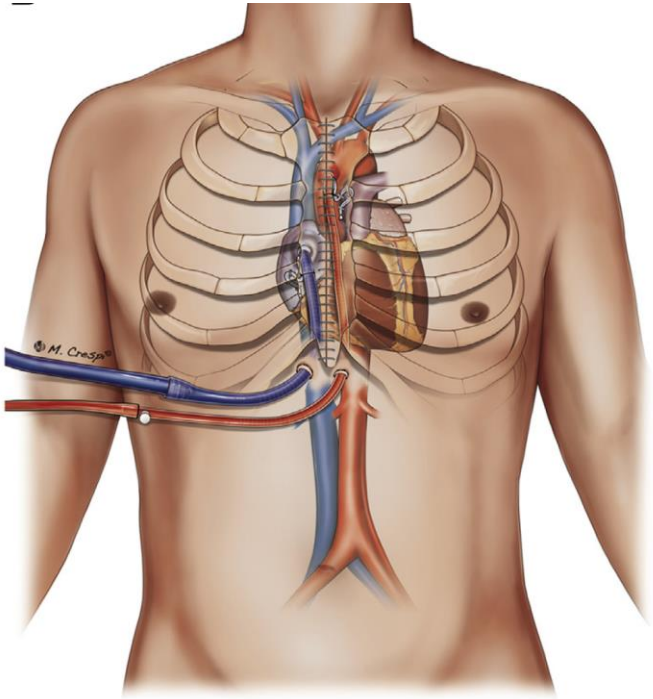
The ELSO Maastricht Treaty for ECLS Nomenclature

Modes		**VV (ECMO)**		**VA (ECMO)**	**VVA (ECMO)**			**AV ($ECCO_2R$)**
Flow direction, from → ML→ to		**V-V, VV-V**	**V-V**	**V-A, VV-A**	**V-VA**	**V-VA**	**V-AV**	**A-V**
Configuration		Single-lumen cannulae	Dual-lumen cannula	Single-lumen cannulae	Single-lumen cannulae from V-V	Dual-lumen cannula from V-V	Single-lumen cannulae from V-A	Single-lumen cannulae
Level 1: Hierarchy	Upper case = major flow cannula Lower case = minor flow cannula	Vcep-V	(dl)V-V, (ca)V-V, (bc)Vcep-V	V-Ad, (dl)VV-Ad	Vv-VAd	(dl)V-VA	V-AdV	(pl)A-V
Level 2: Cannulation site	Indexed	V_f-V_j	(dl)V_f-V, (ca)$V_j$cep-V	V_j-A_f, $V_j V_f$-A_fd, V_j-A_{car}	V_f-$V_j A_f$	(bc)V_j-VA_fd	V_j-$A_f V_f$	(pl)A_{fl}-V_{fr}
Level 3: Tip position	Indexed	V_{ivc}-V_a, V_{ja}cep-V_f	V_{fsvc}-V_f	V_{ja}-$A_{fli}d_p vnt_{al}$, V_{ja}-A_{srg}, V_j-A_i	V_f-$V_{fivc}A_f$, V_f-$V_j A_i$	(ca)V_j-VA_{slc}	$V_{ja}v_c$-$A_{fr}d_p V_{fr}$	(pl)A_{fri}-V_{fli}
Level 4: Cannula dimension	OD/L, L is never given unless OD first	V21/50-V17, $V21_f$-$V17_{fivc}$ $V23/25_a$-$V17_f$	(dl31)V-V, (ca32)$V_j$cep-V	V25/25-A17/18, $V29_{fa}$-$A_f d_t$ $V25_{flsvc}$-$A_{fl}19d_p$	$V25/38_j$-V_f $A19/18_f d_t$	(dl23)V-VA_f	$V25/25_{ja}v_a$-$A21_{fr}d_p V17/50_{fr}$	(pl)$A15/17_{fr}$-$V15_{fl}$

Main configurations of VA-ECMO

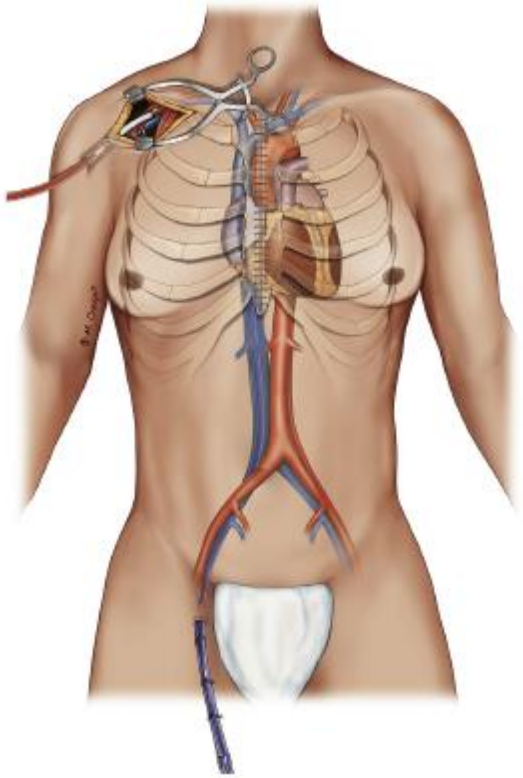


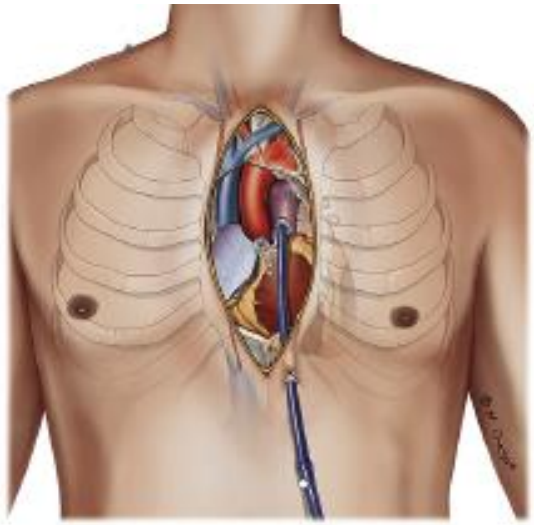
Peripheral VA-ECMO

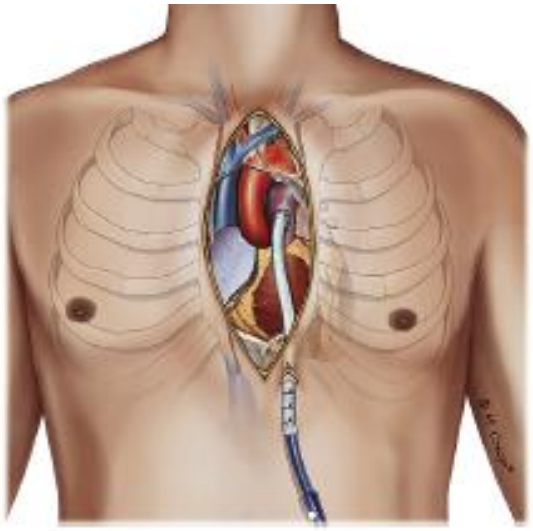


Central VA-ECMO

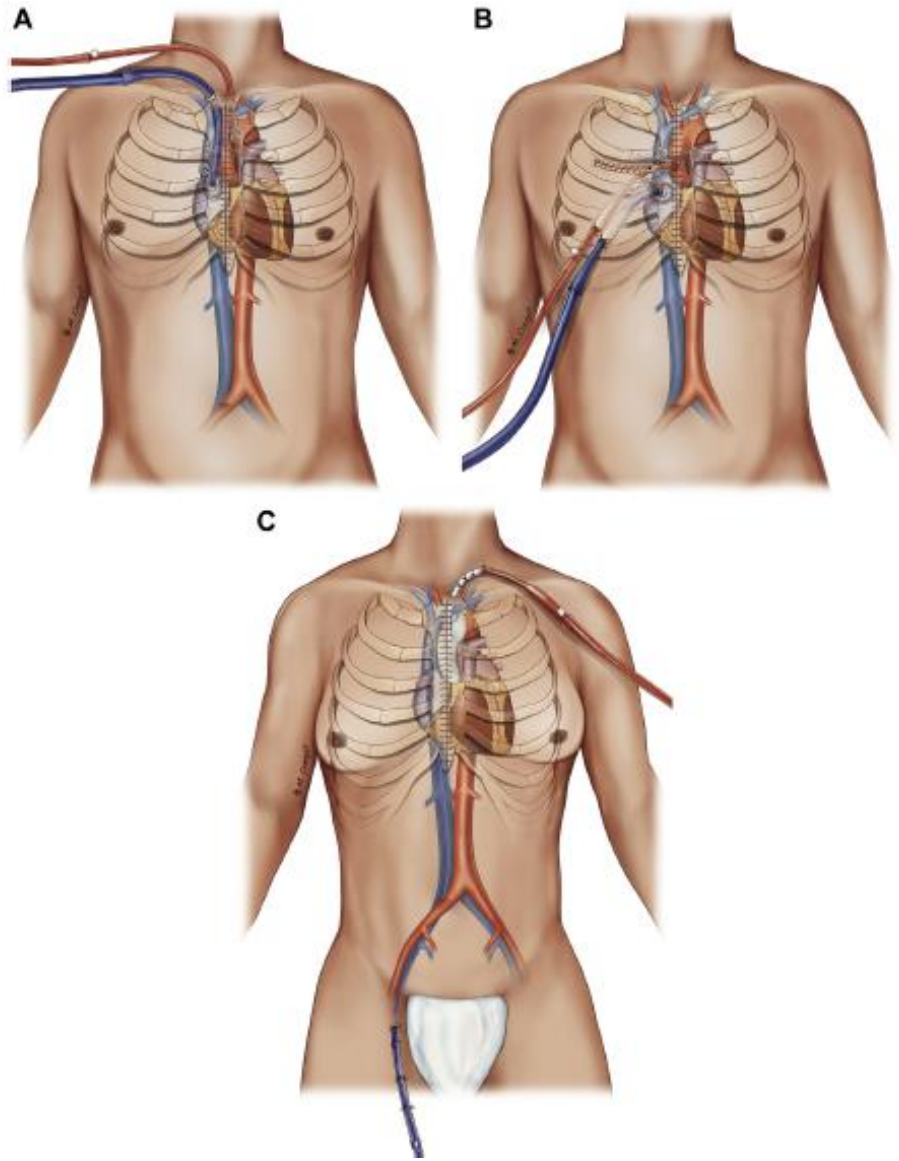
Other configurations of VA-ECMO

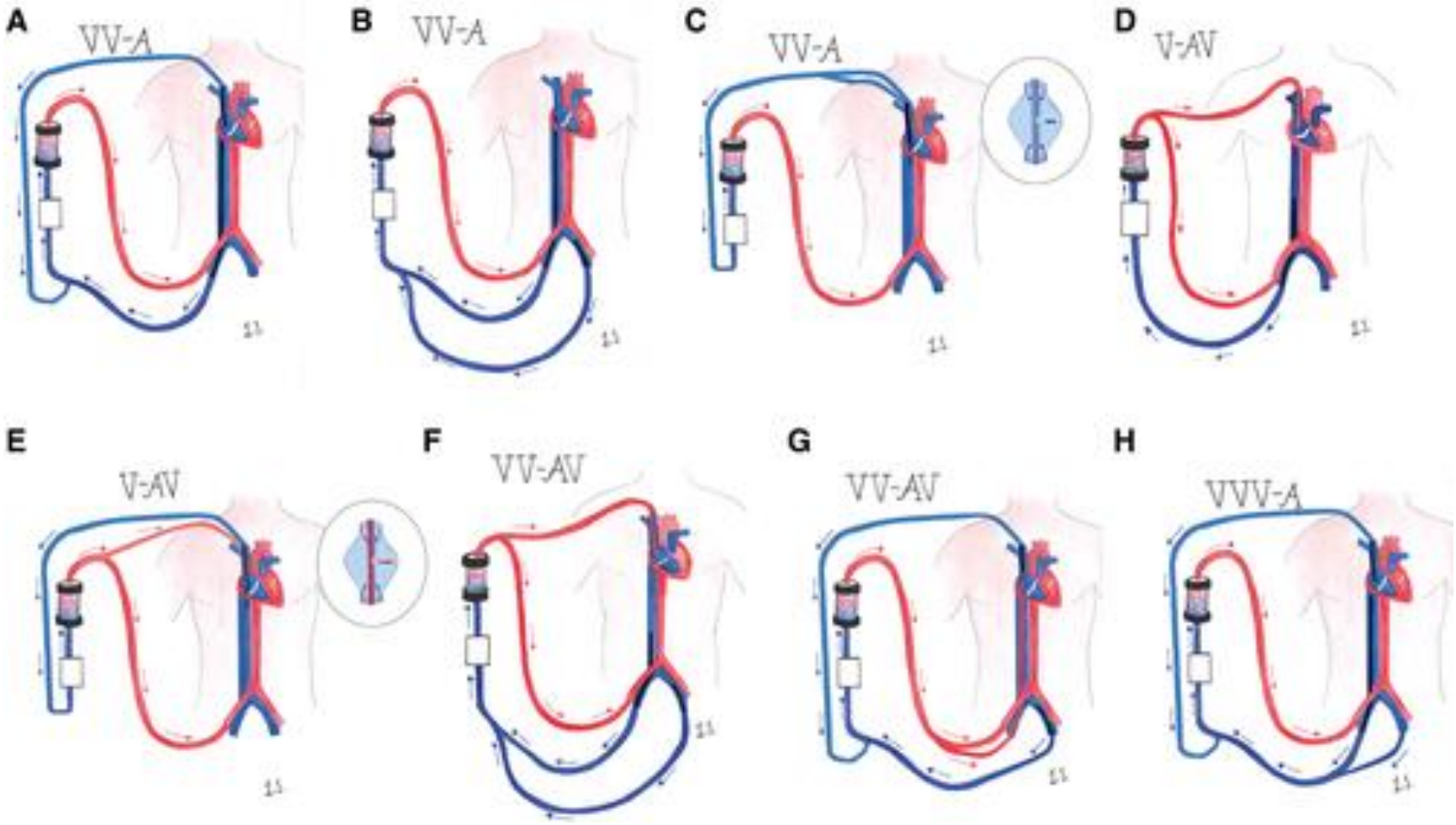


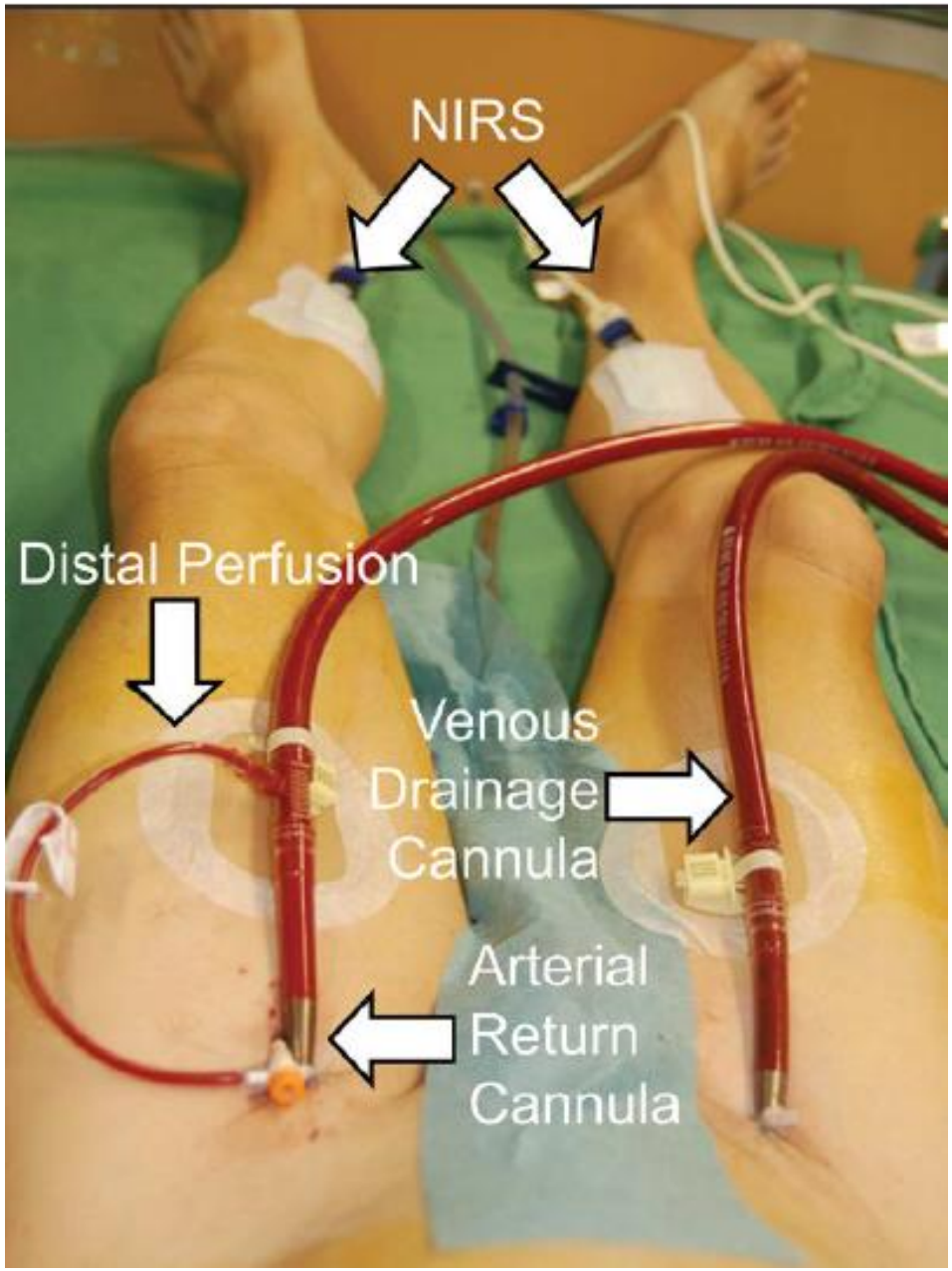




Externalizations of central VA-ECMO




A
VV-A
B
VV-A
C
VV-A
D
V-AV
E
V-AV
F
VV-AV
G
VV-AV
H
VVV-A



Peripheral VA-ECMO

Decision Making in Adult VA-ECMO for Acute Cardiac Failure

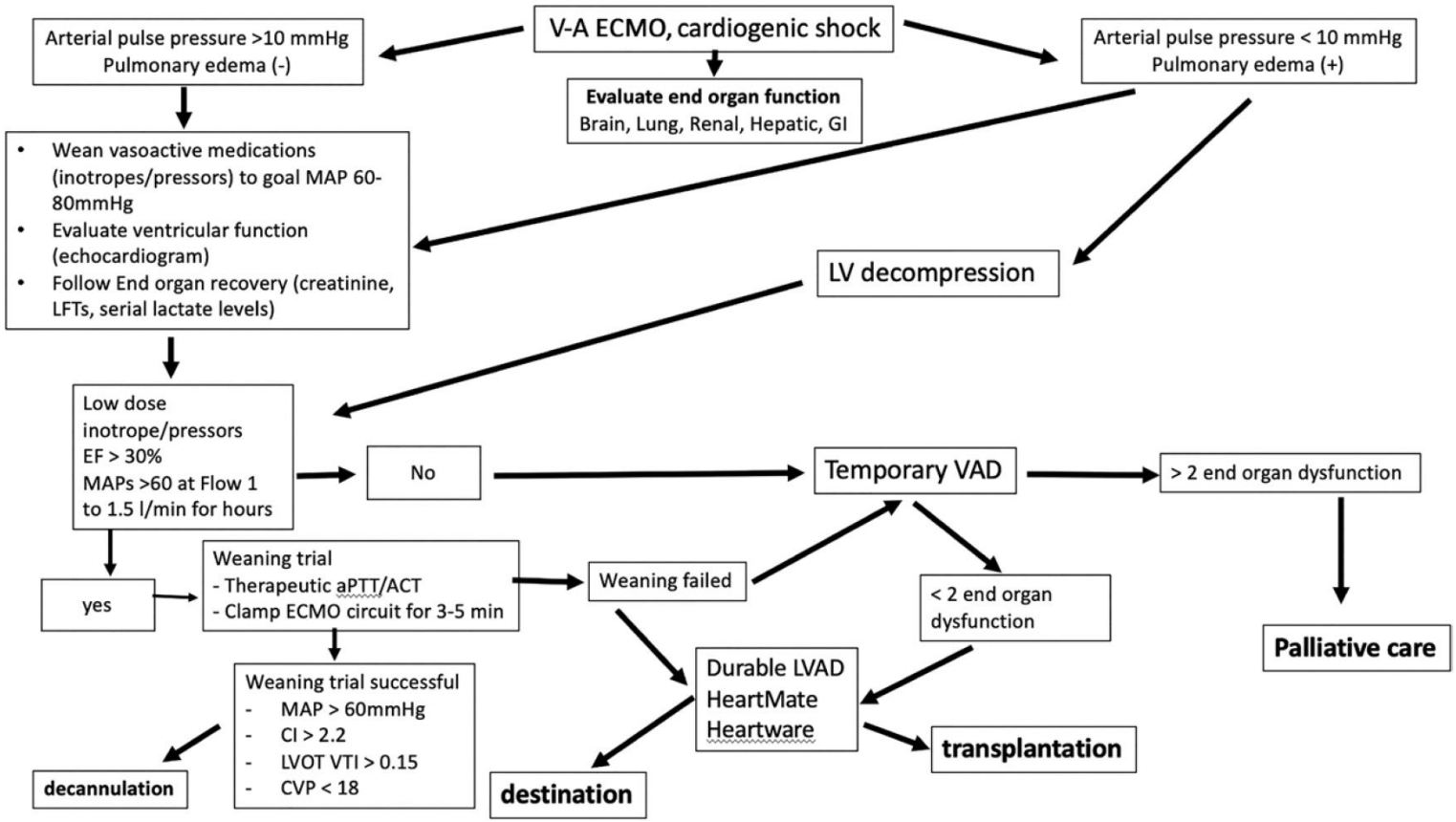
VA ECMO may support patients for days or weeks as a "bridge-to-decision" that includes weaning after recovery of cardiac function, transplantation, long-term mechanical circulatory
support (ventricular assist devices), and withdrawal in the case of futility

When to use and not use VA-ECMO for cardiogenic shock?

ELSO Interim Guidelines for Venoarterial Extracorporeal Membrane Oxygenation in Adult Cardiac Patients

Roberto Lorusso,* Kiran Shekar,† Graeme MacLaren,‡ Matthieu Schmidt,§ Vincent Pellegrino,¶ Bart Meyns,‖ Jonathan Haft,# Leen Vercaemst,‖ Federico Pappalardo,** Christian Bermudez,†† Jan Belohlavek,‡‡ Xiaotong Hou,§§ Udo Boeken,¶¶ Roberto Castillo,‖‖ Dirk W. Donker,##*** Darryl Abrams,††† Marco Ranucci,‡‡‡ Kasia Hryniewicz,§§§ Ivan Chavez,§§§ Yih-Sharng Chen,¶¶¶ Leonardo Salazar,‖‖‖ and Glenn Whitman###

REVIEWERS: Hergen Buscher,**** Rodrigo Diaz,†††† Thomas Mueller,‡‡‡‡ and Alain Combes,§§§§



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Cardiogenic shock suitable for ECMO is generally characterized by:

- systemic systolic pressure less than 90 mmHg
- urine output < 30 ml/hour
- lactate over 2
- SVO_2 less than 60%
- altered conscious state for 6 hours
- unresponsive to optimal treatment

2020 EACTS/ELSO/STS/AATS Expert Consensus on Post-Cardiotomy Extracorporeal Life Support in Adult Patients

Roberto Lorusso, MD, PhD, Chairperson,* Glenn Whitman, MD, Chairperson,* Milan Milojevic, MD, PhD,* Giuseppe Raffa, MD, PhD, David M. McMullan, MD, Udo Boeken, MD, PhD, Jonathan Haft, MD, Christian A. Bermudez, MD, Ashish S. Shah, MD, and David A. D'Alessandro, MD

Recommendations for Indications, Contraindications and Prognostication of PC-ECLS

Recommendations	Class[a]	Level[b]
It is recommended that PC support be initiated prior to end-organ injury or onset of anerobic metabolism (lactate level <4 mmol/l) in patients with likelihood of myocardial recovery and in the absence of uncontrollable bleeding not amenable to surgical repair.[14,33]	I	B
When the likelihood of native myocardial recovery is low, PC ECLS is recommended in patients who are eligible for LT-MCS or a HTx.	I	C
The early use of ECLS after cardiac surgery in a patient with an IABP and optimal medical therapy, with failure to wean from CPB or marginal hemodynamics is recommended.[33]	I	B
Significant comorbidities, advanced age, elevated lactate level and renal injury are risk factors associated with death and should be considered prior to ECLS initiation.[25,27,33]	IIa	B
Preoperative implant of ECLS may be considered in patients in very poor condition (hemodynamic or metabolic) or with structural cardiac anomalies (postacute MI VSD, severe lung edema or dysfunction due to underlying cardiac disease) to facilitate perioperative management (bridge to surgery).	IIb	C
It should be considered that the type and modality of ECLS (uni or biventricular failure, right or left ventricular compromise, preoperative, intraoperative or postoperative cardiocirculatory failure, acute or chronic cardiac dysfunction, cardiogenic shock or cardiac arrest, including alternative mechanical support device) are discussed based on the type of hemodynamic condition and patient characteristics.	IIa	C

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Table 2. The SAVE Score[6]

Parameter	Score
Acute cardiogenic shock diagnosis group (select one or more)	
Myocarditis	3
Refractory VT/VF	2
Post heart or lung transplantation	3
Congenital heart disease	–3
Other diagnoses leading to cardiogenic shock requiring VA ECMO	0
Age (yrs)	
18–38	7
39–52	4
53–62	3
≥63	0
Weight (kg)	
≤65	1
65–89	2
≥90	0
Acute pre-ECMO organ failures (select one or more if required)	
Liver failure*	–3
Central nervous system dysfunction†	–3
Renal failure‡	–3
Chronic renal failure§	–6
Duration of intubation before initiation of ECMO (h)	
≤10	0
11–29	–2
≥30	–4
Peak inspiratory pressure ≤20 cmH_2O	3
Pre-ECMO cardiac arrest	–2
Diastolic blood pressure before ECMO ≥ 40 mm Hg¶	3
Pulse pressure before ECMO ≤20 mm Hg¶	–2
HCO_3 before ECMO ≤15 mmol/L¶	–3
Constant value to add to all calculations of SAVE score	–6
Total score	–35 to 17

Total SAVE score	Risk class	Survival (%)
>5	I	75
1–5	II	58
–4 to 0	III	42
–9 to –5	IV	30
≤ –10	V	18

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- Cardiac recovery unlikely and no indication for heart transplant or durable left ventricular (LV) assists device
- Poor life expectancy (end-stage peripheral-organ diseases, malignant tumor, massive pulmonary embolisms in cancer patients, chemotherapy-induced chronic cardiomyopathy, etc.)
- Severe aortic valve regurgitation
- Severe vascular disease with extensive aortic and peripheral vessel involvement (calcification, stenosis, and closure), including axillary arteries
- Acute Type A or B aortic dissection with extensive aortic branches (ascending, supra-aortic and femoral) involvement (preoperatively)
- Severe neurologic impairment (*i.e.*, prolonged anoxic brain damage, extensive trauma and bleeding)
- Severe immunologic disease with marked blood and coagulation disorders
- Liver cirrhosis (Child-Pugh class B and C)

Early invasive therapy in comatose patients with out-of-hospital cardiac arrest can be contraindicated in case of:

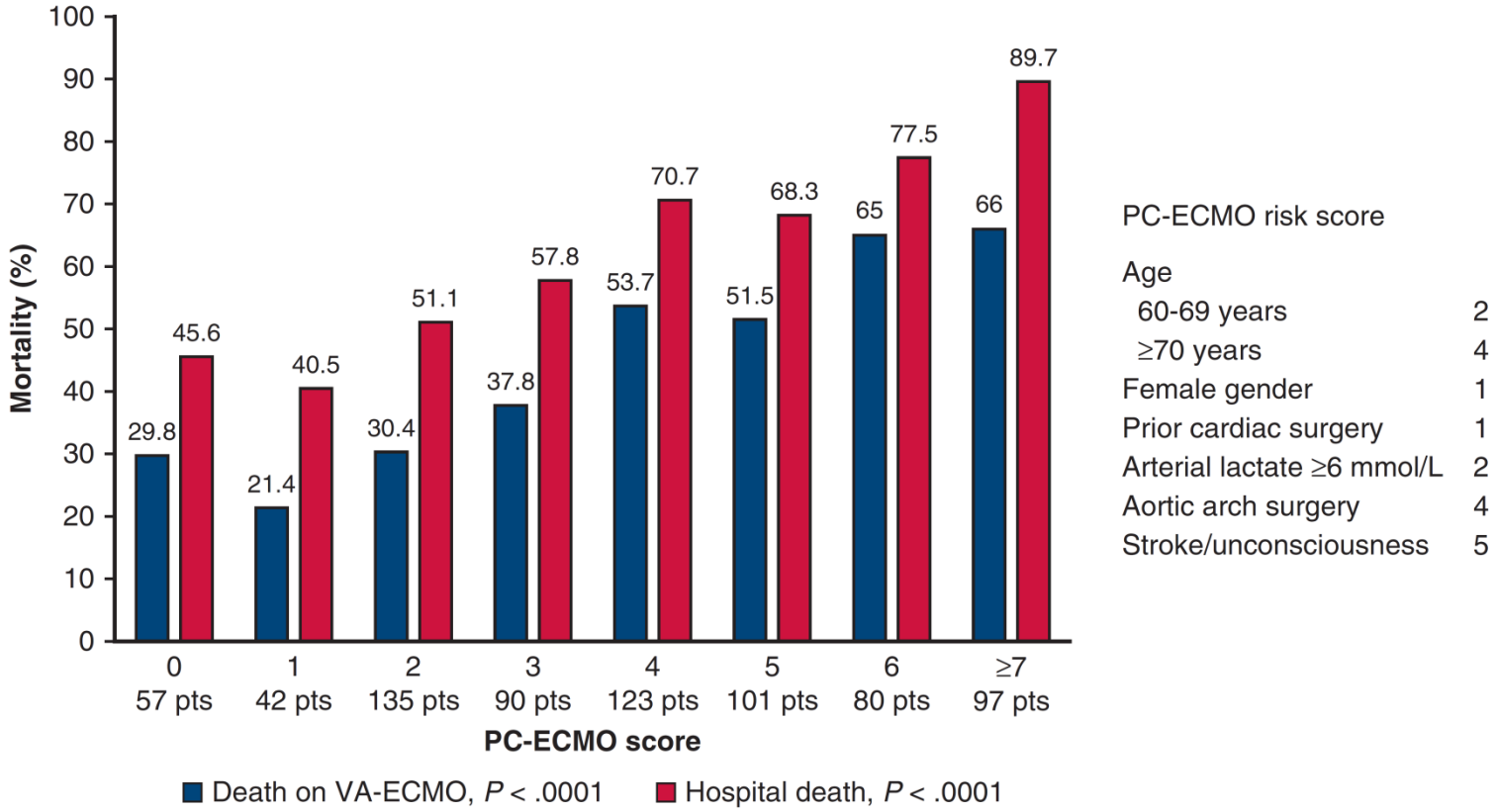
- An initial nonshockable rhythm
- Unwitnessed arrest
- Lack of bystander cardiopulmonary resuscitation
- >30 min to return of spontaneous circulation or ongoing CPR
- pH <7.2
- Lactate >7 mmol/L
- Age >85 years
- End-stage renal disease
- Noncardiac cause of arrest

American College of Cardiology. Cardiac arrest: a treatment algorithm for emergent invasive cardiac procedures in the resuscitated comatose patient. J Am Coll Cardiol. 2015;66:62–73.

Multicenter study on postcardiotomy venoarterial extracorporeal membrane oxygenation

Fausto Biancari, MD, PhD,[a,b] Magnus Dalén, MD, PhD,[c] Antonio Fiore, MD,[d] Vito G. Ruggieri, MD, PhD,[e] Diyar Saeed, MD,[f] Kristján Jónsson, MD, PhD,[g] Giuseppe Gatti, MD,[h] Svante Zipfel, MD,[i] Andrea Perrotti, MD, PhD,[j] Karl Bounader, MD,[k] Antonio Loforte, MD, PhD,[l] Andrea Lechiancole, MD,[m] Marek Pol, MD,[n] Cristiano Spadaccio, MD,[o] Matteo Pettinari, MD,[p] Sigurdur Ragnarsson, MD, PhD,[q] Khalid Alkhamees, MD,[r] Giovanni Mariscalco, MD, PhD,[s] and Henryk Welp, MD,[t] the PC-ECMO Study Group

J Thorac Cardiovasc Surg 2020;159:1844-54



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The goal of VA-ECMO is to maintain systemic oxygen delivery at least 3 times oxygen consumption (the DO2:VO2 ratio is >3) (normal DO2:VO2 ratio is 5, in shock is 2)

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Table 8. Clinical Monitoring During Venoarterial Extracorporeal Membrane Oxygenation

Invasive arterial blood pressure monitoring/right radial artery

- Pulse pressure—measure of native contractility *vs.* ECMO blood flow
- Oxygen saturation—measure of oxygenation in proximal aortic arch/detection of differential oxygenation

Pulse oximetry/right hand

- Oxygen saturation—measure of oxygenation in proximal aortic arch/detection of differential oxygenation

Pulmonary artery catheter

- Detect elevated left-sided filling pressure
- Support indication for adjunct LV unloading
- Continuous cardiac output monitoring as indication of residual pulmonary artery flow (alternatively, residual pulmonary artery flow can be monitored by measuring end-tidal CO_2)

Echocardiography

- Early cardiac diagnostics and identification of contraindications to VA ECMO
- Visualization of proper vascular access and guidance cannulation
- Optimal tailoring of ECMO support
- Serial assessment of hemodynamic and cardiac conditions
- Cardiac assessment during weaning trial

Electrocardiography

- Consider continuous, multilead electrocardiographic monitoring

NIRS

- Monitoring of limb (single and bilateral comparison) and brain perfusion

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Criteria to be used for the assessment of LV unloading need

Method	Factor	Grade of severity		
Arterial line				
	Arterial Pulsatility	Mild weakness	Moderate weakness	Almost Pulseless
Central venous Line				
	$ScvO_2$	75-55%	55-45%	<45%
	CVP	8-12 mmHg	12-16 mmHg	> 20 mmHg
Echocardiogram				
	AV	Opening every 2 bpm	Opening every 3-4 bpm	Closure
	LV distension	Mild	Moderate	Severe
	LA distension	Mild	Moderate	Severe
	"Smoke like" effect	Mild	Moderate	Severe
	IVC dilatation[1]	1.5 to 2.5 cm	>2.5 cm	>2.5 cm
	IVC collapse[2]	<50%	<50%	No change
Swan Ganz Catheter				
	PCWP	13-18 mmHg	18-25 mmHg	>25 mmHg
Chest X-ray				
	Congestion[3]	Alveolar edema	Interstitial edema	Redistribution

$ScvO_2$: central venous blood oxygen saturation; CVP: central venous pressure, AV: aortic valve; bpm: beats per minute; LV: left ventricle; LA: left atria, PCWP: post capillary wedge pressure.

Less-Invasive LV-Unloading Maneuvers To Be Applied

IABP + Less-Invasive LV Unloading Maneuvers To Be Applied

Invasive Catheter-Based LV-Unloading Maneuvers To Be Applied

ELSO Interim Guidelines for Venoarterial Extracorporeal Membrane Oxygenation in Adult Cardiac Patients

Roberto Lorusso,* Kiran Shekar,† Graeme MacLaren,‡ Matthieu Schmidt,§ Vincent Pellegrino,¶ Bart Meyns,‖ Jonathan Haft,# Leen Vercaemst,‖ Federico Pappalardo,** Christian Bermudez,†† Jan Belohlavek,‡‡ Xiaotong Hou,§§ Udo Boeken,¶¶ Roberto Castillo,‖‖ Dirk W. Donker,##*** Darryl Abrams,††† Marco Ranucci,‡‡‡ Kasia Hryniewicz,§§§ Ivan Chavez,§§§ Yih-Sharng Chen,¶¶¶ Leonardo Salazar,‖‖‖ and Glenn Whitman###

REVIEWERS: Hergen Buscher,**** Rodrigo Diaz,†††† Thomas Mueller,‡‡‡‡ and Alain Combes,§§§§

Table 4. Options, Procedures, and Related Efficacy Potentially Available to Pursue or Favoring Left Ventricular Unloading During Venoarterial Extracorporeal Life Support

Type of Procedure	Efficacy
Less-invasive maneuvers	
Reduced ECMO flow	√√√
Inotropes	√√
Vasodilation	√√
Increased PEEP	√√
Diuretics	√
Invasive (catheter-based) maneuvers	
Trans-aortic suction device	
Impella	√√√√√
Pulsatile trans-aortic suction device	√√√
Atrial septostomy	√√√ - √√√√
Left ventricular venting through the apex	√√√√√
Left ventricular venting through the mitral valve	√√√√√
Pulmonary artery venting	√√√
IABP	√√
Tran-septal atrial cannula	√√√√
Additional venous cannula	√√
Central ECLS	√√√

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Table 10. Major Complications of Venoarterial Extracorporeal Membrane Oxygenation and Suggested Management

Complication	Management
Malpositioning of cannula	Routine use of ultrasound/fluoroscopy for cannulation procedure
Ischemia of cannulated leg	Prophylactic use of small antegrade perfusion cannula, NIRS monitoring of calf muscle before, during and after VA ECMO oximetry, pulse Doppler of cannulated leg
Deep vein thrombosis of femoral/caval vein	Adequate anticoagulation during and after VA ECMO, Ultrasound control of vessels after decannulation
Overloading of LV	Reduce MAP to lowest acceptable value Use a small dose of inotropes, avoid vasopressors if possible Use PAC and end-tidal CO_2 for monitoring of pulmonary perfusion Regular echocardiography Venting of LV when indicated (see proper table)
Differential oxygenation	Monitoring of BGA and saturation on right arm NIRS monitoring of the brain and lower limbs Optimize ventilation VAV cannulation only if necessary
Lower body hyperoxemia/hypocapnia	BGA post membrane after every change in ECMO settings Adjust gas flow and blender settings to achieve Normocapnia and slight hyperoxemia (150 mm Hg) after the oxygenator
Device clotting	Adequate anticoagulation Regular maintenance by control of aPTT or ACT, D-Dimers, trans-membrane pressure and gas transfer capacity—If relevant, timely system replacement
Hemorrhage	Adequate anticoagulation (reduced or stop heparin administration in case of excessive bleeding or life-threatening hemorrhage) Regular control of aPTT or ACT, platelets, fibrinogen NIRS monitoring of brain Avoid every unnecessary invasive procedure

2020 EACTS/ELSO/STS/AATS Expert Consensus on Post-Cardiotomy Extracorporeal Life Support in Adult Patients

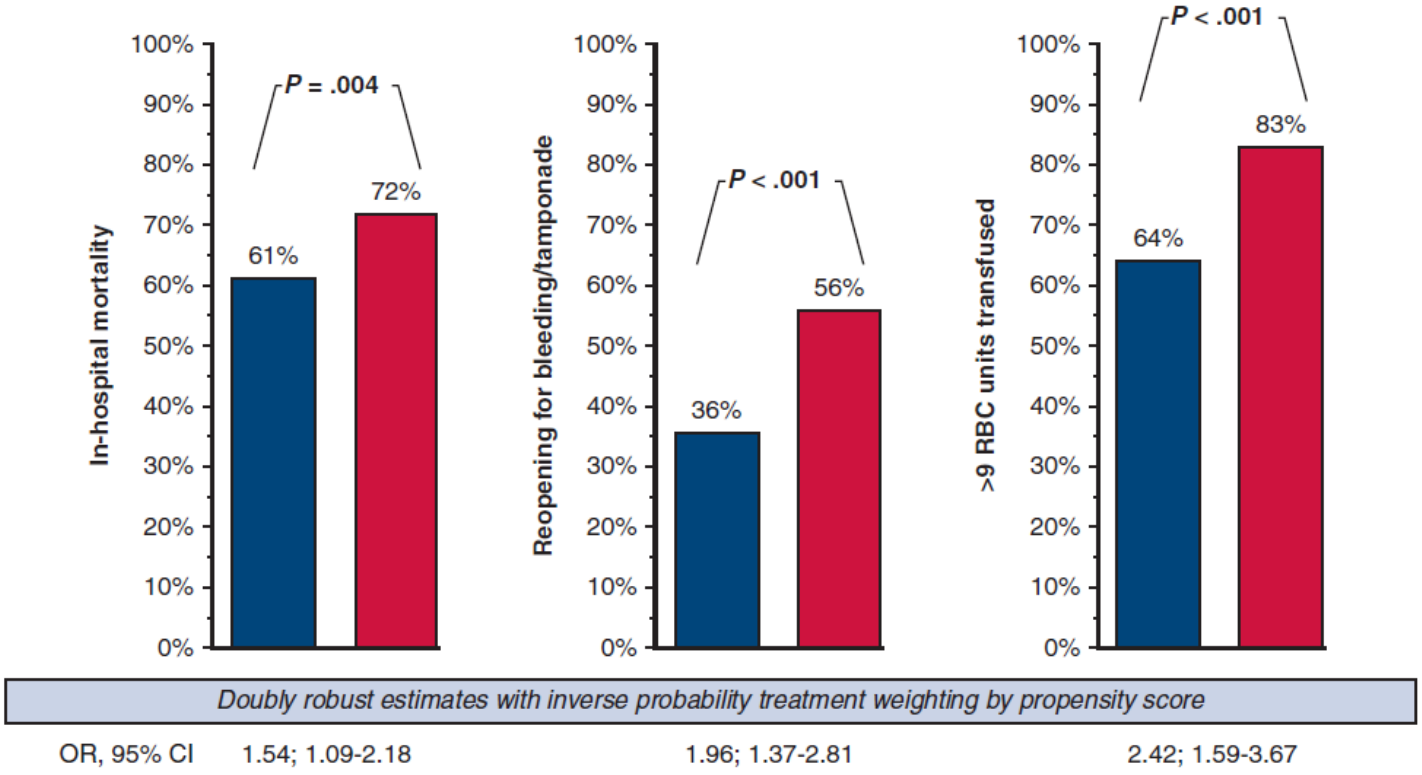
Roberto Lorusso, MD, PhD, Chairperson,* Glenn Whitman, MD, Chairperson,* Milan Milojevic, MD, PhD,* Giuseppe Raffa, MD, PhD, David M. McMullan, MD, Udo Boeken, MD, PhD, Jonathan Haft, MD, Christian A. Bermudez, MD, Ashish S. Shah, MD, and David A. D'Alessandro, MD

Recommendations for ECLS Modes and Configurations

Recommendations	Class[a]	Level[b]
Peripheral cannulation approach should be considered in patients with PCS and for V-A ECLS in the presence of LV or biventricular failure.[41,43–45]	IIa	B

Peripheral versus central extracorporeal membrane oxygenation for postcardiotomy shock: Multicenter registry, systematic review, and meta-analysis

Giovanni Mariscalco, MD, PhD,[a] Antonio Salsano, MD, PhD,[b] Antonio Fiore, MD,[c] Magnus Dalén, MD, PhD,[d] Vito G. Ruggieri, MD, PhD,[e] Diyar Saeed, MD,[f] Kristján Jónsson, MD, PhD,[g] Giuseppe Gatti, MD,[h] Svante Zipfel, MD,[i] Angelo M. Dell'Aquila, MD,[j] Andrea Perrotti, MD, PhD,[k] Antonio Loforte, MD, PhD,[l] Ugolino Livi, MD,[m] Marek Pol, MD,[n] Cristiano Spadaccio, MD,[o] Matteo Pettinari, MD,[p] Sigurdur Ragnarsson, MD, PhD,[q] Khalid Alkhamees, MD,[r] Zein El-Dean, MRCS, LLM,[a] Karl Bounader, MD,[s] and Fausto Biancari, MD, PhD,[t,u] the PC-ECMO group*



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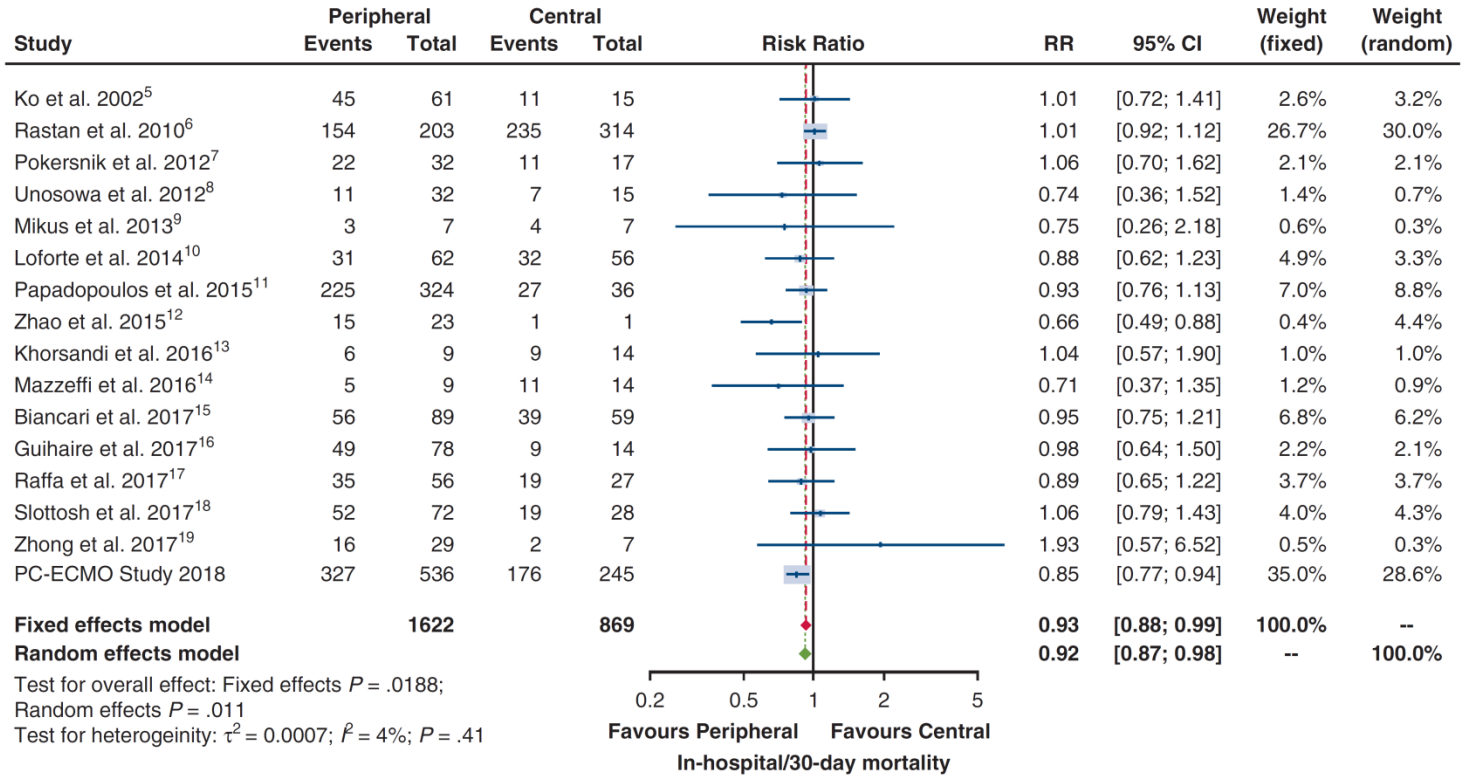
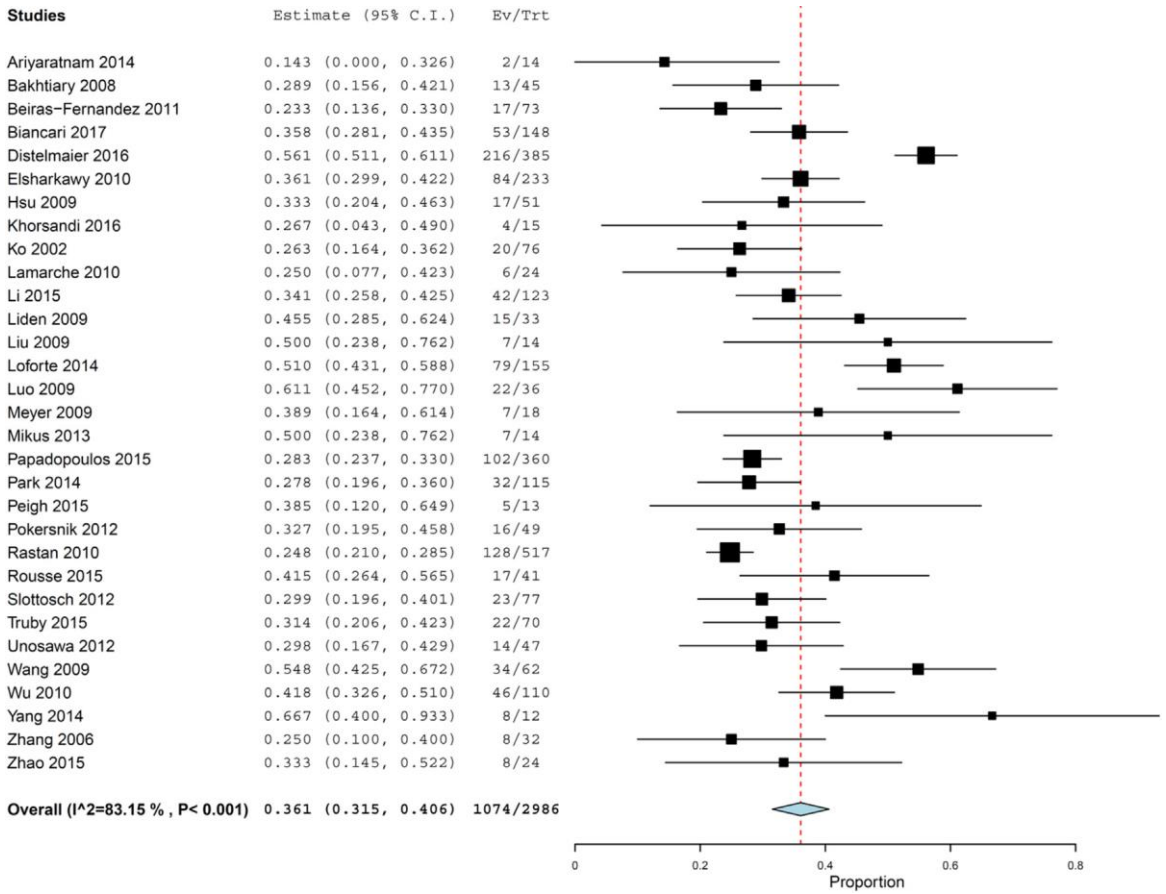


Meta-Analysis of the Outcome After Postcardiotomy Venoarterial Extracorporeal Membrane Oxygenation in Adult Patients

Fausto Biancari, MD, PhD[*,†,1], Andrea Perrotti, MD[‡], Magnus Dalén, MD, PhD[§], Mariapia Guerrieri, MS[†], Antonio Fiore, MD[‖], Daniel Reichart, MD[¶], Angelo M. Dell'Aquila, MD, PhD[**], Giuseppe Gatti, MD[††], Tero Ala-Kokko, MD, PhD[‡‡], Eeva-Maija Kinnunen, MD, PhD[*], Tuomas Tauriainen, MS[*], Sidney Chocron, MD, PhD[‡], Juhani K.E. Airaksinen, MD, PhD[*], Vito G. Ruggieri, MD, PhD[§§], Debora Brascia, MD[*]

Journal of Cardiothoracic and Vascular Anesthesia 2018;32:1175–1182



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Original Article | Published: 03 June 2021

Predictors of Mortality in Patients Treated with Veno-Arterial ECMO for Cardiogenic Shock Complicating Acute Myocardial Infarction: a Systematic Review and Meta–Analysis

Shahmir Sohail, Eddy Fan, Farid Foroutan, Heather J. Ross, Filio Billia & Ana Carolina Alba

Journal of Cardiovascular Translational Research (2021) | Cite this article

72 studies (10,276 patients) were included with a **pooled mortality estimate of 58 %**.

With high confidence in estimates, failure to achieve **TIMI III flow** and **left main culprit** were identified as factors associated with higher mortality.

With low-moderate confidence, older age, high BMI, renal dysfunction, increasing lactate, prothrombin activity < 50%, VA-ECMO implantation after revascularization, and non-shockable ventricular arrythmias were identified as factors associated with mortality

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Table 3
Pooled Rates of Early Outcomes

Outcomes	No. of Studies	No. of Patients	Proportion/Mean (95% CI)	I^2
Hospital survival, %	31	2,986	36.1 (31.5-40.8)	84%
Weaning from VA-ECMO, %	24	2,049	59.5 (54.6-64.3)	77%
Reoperation for bleeding, %	18	1,779	42.9 (34.2-51.5)	93%
RBC units transfused	11	1,241	17.7 (13.3-22.1)	99%
Major neurological event, %	16	1,736	11.3 (7.8-14.8)	79%
Limb ischemia, %	16	1,909	10.8 (8.0-13.5)	70%
Lower limb amputation, %	5	330	1.1 (0.0-2.3)	0%
Deep sternal wound infection/mediastinitis, %	4	490	14.7 (4.0-25.4)	92%
Renal replacement therapy, %	19	1,979	47.1 (38.9-55.2)	92%
Ventricular assist device, %	21	1,685	2.3 (1.3-3.4)	57%
Heart transplantation, %	21	1,685	1.9 (1.0-2.8)	50%
Intensive care unit stay, d	10	589	13.3 (10.2-16.4)	95%
In-hospital stay, d	9	1,154	22.5 (17.7-27.3)	95%

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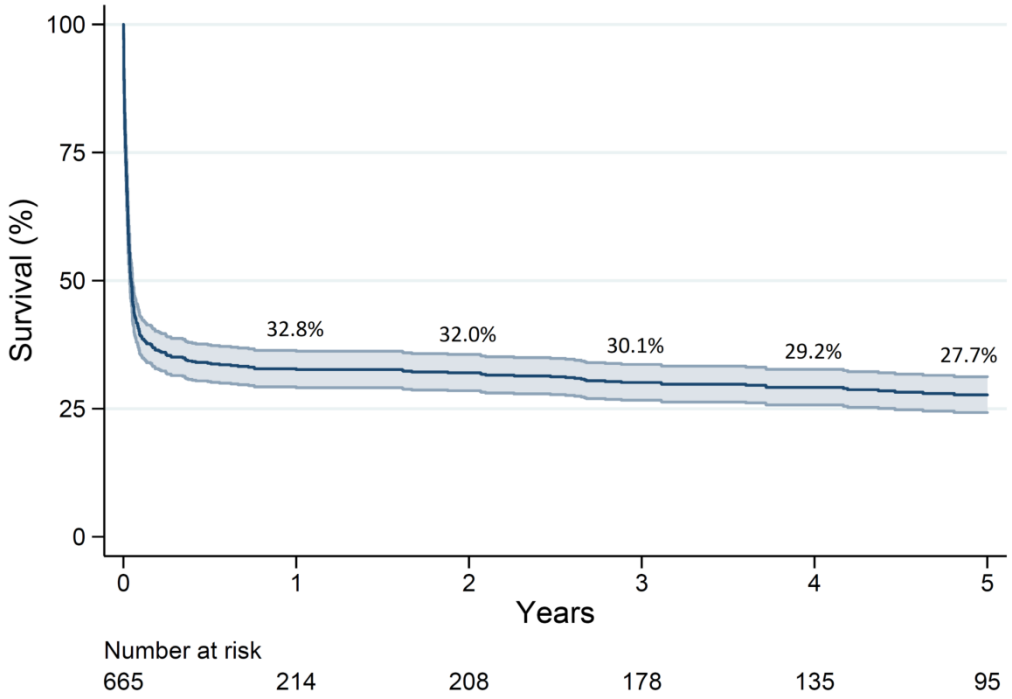
One-year survival rate was 30.9% (95% CI 24.3-37.5)

European Heart Journal
Acute Cardiovascular Care

Five-year survival after post-cardiotomy veno-arterial extracorporeal membrane oxygenation

Fausto Biancari ✉, Andrea Perrotti, Vito G Ruggieri, Giovanni Mariscalco, Magnus Dalén, Angelo M Dell'Aquila, Kristján Jónsson, Sigurdur Ragnarsson, Dario Di Perna, Karl Bounader ... Show more

European Heart Journal. Acute Cardiovascular Care, Volume 10, Issue 6, August 2021,



Recommendations for Education and Training

Recommendations	Class[a]	Level[b]
Didactic and water drills are recommended as a routine and repetitive part of ECLS training for providers.[197]	I	B
ECLS simulation is recommended for ECLS multispecialty teams as well as individual specialists.[195,202]	I	B
ECLS simulation is recommended for team-based learning specialties.[197-201]	I	B

[a]Class of recommendation; [b]Level of evidence.

ECLS, extracorporeal life support.